

The conservation of Peninsular Malaysian *Geostachys* (Zingiberaceae)

K.H. Lau

Forest Research Institute Malaysia,
52109 Kepong, Selangor, Malaysia
laukh@frim.gov.my

ABSTRACT. There are currently 15 species of *Geostachys* in Peninsular Malaysia of which 13 are hyper endemic to their localities. Four taxa are categorised as Endangered, eight as Vulnerable and one each as Near Threatened, Least Concern and Data Deficient. Maps showing the Extent of Occurrence and Area of Occupancy for each species are included. Key issues and recommendations on conservation measures, particularly with respect to ecotourism, are discussed.

Keywords. Area of occupancy, assessment, conservation, extent of occurrence, *Geostachys*, Peninsular Malaysia

Introduction

Geostachys (Baker) Ridl. is a genus of lesser-known gingers distributed in Vietnam, Thailand, Sumatra, Peninsular Malaysia and Borneo. Of the 25 taxa currently known (The Plant List, 2013), 15 occur in higher altitude lush rain forests of Peninsular Malaysia (Lau et al., 2007; Lau & Lim, 2012). This makes Peninsular Malaysia the genus hotspot. Among the 15 taxa, 13 are hyper-endemic to their localities and the other two are quite widespread.

In Malaysia, the main threats to lowland forest are from deforestation and changes in land use. Despite their preference for higher altitudes, *Geostachys* habitats suffer from similar disturbances. While there are several works describing the genus in Peninsular Malaysia (Ridley, 1899, 1920, 1924; Holttum, 1950; Stone, 1980), none address the conservation perspective. This paper discusses threats faced by the species and their conservation status. It also complements an earlier account (Lau & Lim, 2012) by presenting further insights into the current conservation issues involving the genus.

Materials and methods

Dried specimens from Universiti Kebangsaan Malaysia Herbarium (UKMB), Kepong Herbarium (KEP), University Malaya Herbarium (KLU), Singapore Herbarium (SING) and Royal Botanic Gardens Kew Herbarium (K) were scrutinized and recorded into

the Botanical Research and Herbarium Management System (BRAHMS). All species were assessed using the modified Malaysian Red List Categories (Chua, 2012). The modification from the standard IUCN (2001) system involves the addition of a Rare (RA) category. This category has this definition: the taxon is not exposed to any known direct or plausible potential threat and does not qualify under the five IUCN criteria AND occurs in not more than two sites OR has an Extent of Occurrence (EOO) not more than 100 km² OR Area of Occupancy (AOO) not more than 10 km². A taxon data information sheet was completed for each species and the information was uploaded into the Malaysia Clearing House Mechanism website (<http://www.chm.frim.gov.my/>). The EOO and AOO were calculated for each species using ArcView GIS 3.2a software. Forest cover data was obtained from the Third National and State Forest Inventories (1991–1993). Field efforts were made to gather fresh data and analyse current threats.

Results

Table 1 summarises the conservation status of each species of *Geostachys* in Peninsular Malaysia.

Table 1. Conservation status of *Geostachys* following the modified Malaysian Red List Categories.

Species	Category	EOO (km ²)*	AOO (km ²)	Endemicity
<i>G. belumensis</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. decurvata</i>	EN D2	n.a.	8	Hyper-endemic
<i>G. densiflora</i>	NT	3,172	32	Widespread
<i>G. elegans</i>	LC	23,108	24	Widespread
<i>G. erectifrons</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. leucantha</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. megaphylla</i>	VU D2	n.a.	8	Hyper-endemic
<i>G. montana</i>	DD	n.a.	4	Hyper-endemic
<i>G. penangensis</i>	EN B2ab(iii)	n.a.	8	Hyper-endemic
<i>G. primulina</i>	EN D2	n.a.	4	Hyper-endemic
<i>G. rupestris</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. secunda</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. sericea</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. tahanensis</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. taipingensis</i>	EN D2	n.a.	8	Hyper-endemic

*EOO can only be calculated if at least 3 localities are present.

The species calculated to be Endangered (EN) are *Geostachys decurvata* (Baker) Ridl., *G. penangensis* Ridl., *G. primulina* Ridl. and *G. taipingensis* Holttum,

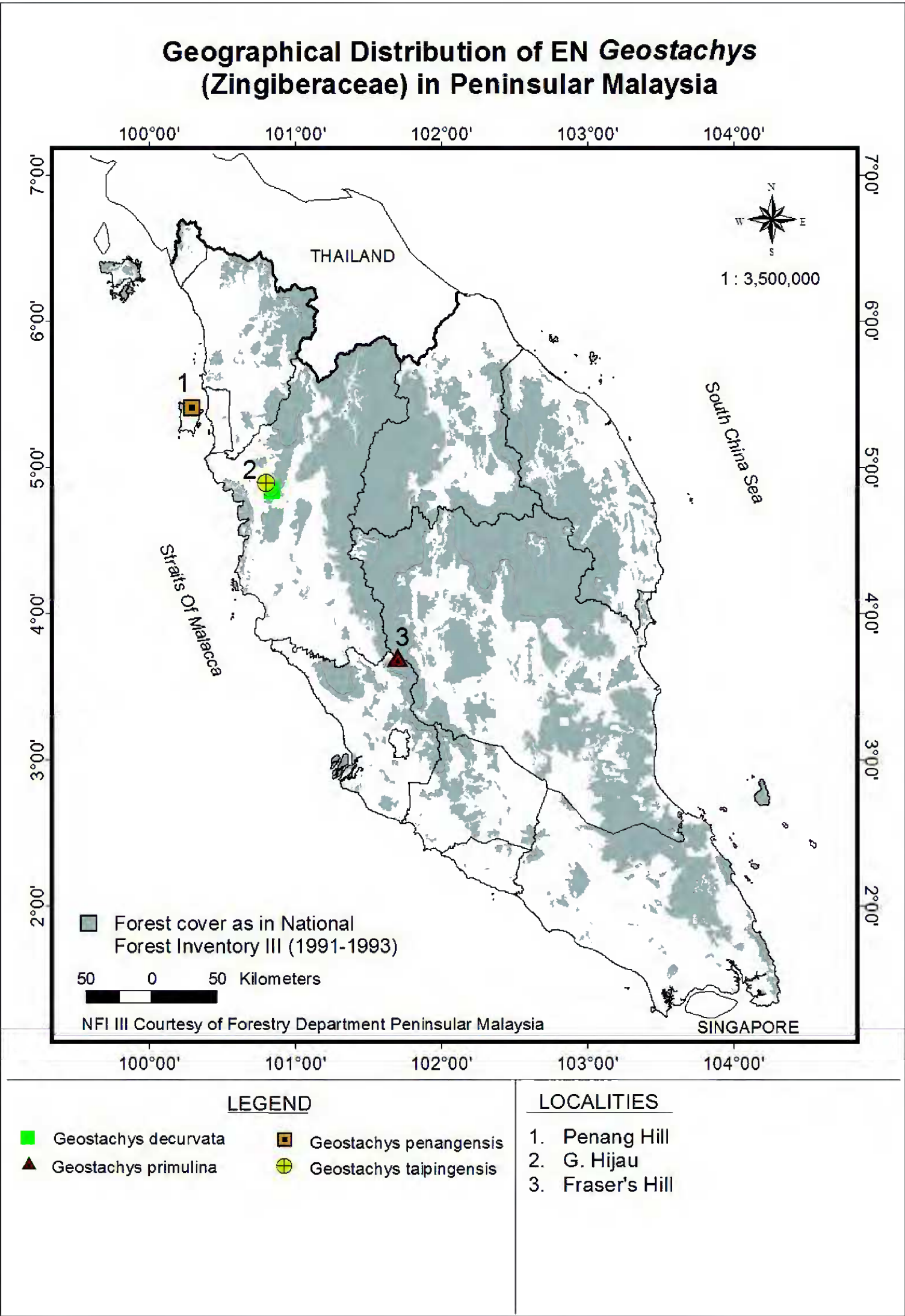


Fig. 1. Distribution of Endangered (EN) *Geostachys* species in Peninsular Malaysia.

all of which are hyper-endemic (Fig. 1). Found growing discreetly within the cool atmosphere of hill forests in Perak, Penang and Pahang, these taxa are endangered mainly due to low numbers of individuals per species. With the exception of *Geostachys penangensis*, several attempts to locate additional populations of these species in these forest reserves proved futile. *Geostachys decurvata* and *G. taipingensis* occur sympatrically on Gunung (G.) Hijau, Maxwell's Hill. These two taxa have both been very infrequently collected and *G. taipingensis* has not been collected for the herbarium since 1949. Lau (2006) reported the rediscovery of *Geostachys primulina* from Fraser's Hill for the first time in more than 80 years. *Geostachys penangensis* can still be found quite abundantly on Penang Hill (Lau, 2004) with populations at several locations on the hill such as Government Hill, Tiger Hill, Western Hill and Moniot Road West. However, road widening activities along the main road (Jalan Tuanku Yahaya Petra) have caused much destruction to the clumps. The increase in human activities on the hill is of concern and long-term monitoring of the impacts on the populations is required. In addition, the sites of these four taxa are also used as eco-forest trails and are exposed to the risk of being trampled.

The Vulnerable (VU) taxa are *Geostachys belumensis* C.K.Lim & K.H.Lau, *G. erectifrons* K.H.Lau, C.K.Lim & K.Mat-Salleh, *G. leucantha* B.C.Stone, *G. megaphylla* Holttum, *G. rupestris* Ridl., *G. secunda* (Baker) Ridl., *G. sericea* (Ridl.) Holttum and *G. tahanensis* Holttum (Fig. 2). In Taman Negara National Park, three taxa are found, namely *Geostachys erectifrons*, *G. sericea* and *G. tahanensis*. Their distributions are, however, very localised. So far, *Geostachys erectifrons* is only known from the area between Permatang and Kubang campsites (Merapoh) at an elevation of 1000–1200 m (Lau et al., 2005). Scattered clumps can be seen on ridges and slopes along both sides of the main trail. The distribution of *Geostachys tahanensis* is also very restricted, occurring on a different side of the mountain near Kuala Tahan Rest Camp, formerly known as Wray's Camp, at about 1100 m above sea level. *Geostachys sericea* has a wider distribution on both the Kuala Tahan and Merapoh sides, but is loosely scattered from the lower montane forest to upper montane forest. Until more populations are discovered beyond these well-used trails and spots, they remain vulnerable as they are at risk of being trampled or collected. For *Geostachys belumensis*, some of the populations in Gerik are now likely protected since 18,866 ha of the Amanjaya Forest Reserve (FR) was gazetted in May 2013. The area has also been identified as an important wildlife corridor under the Central Forest Spine (CFS) Masterplan. This provides protection to many other flora and fauna species along the East-West Highway. Recent discoveries include populations in Piah FR (Perak) and *G. Tebu* (Terengganu) (C.K. Lim pers. obs.). However, the type location of this taxon, which is in Gerik, is showing signs of degradation due to encroachment. In particular the surrounding area has been cleared, probably for the harvesting of non-timber forest products. *Geostachys leucantha* and *G. megaphylla* are found in G. Ulu Kali (Genting Highlands) and G. Brinchang (Cameron Highlands) respectively. Although there are no immediate direct threats to these populations, the environmental impacts arising from non-forest land use will likely affect the viability of the populations. Infrastructure projects, such as for resorts, power lines and slope enhancement structures, as well as

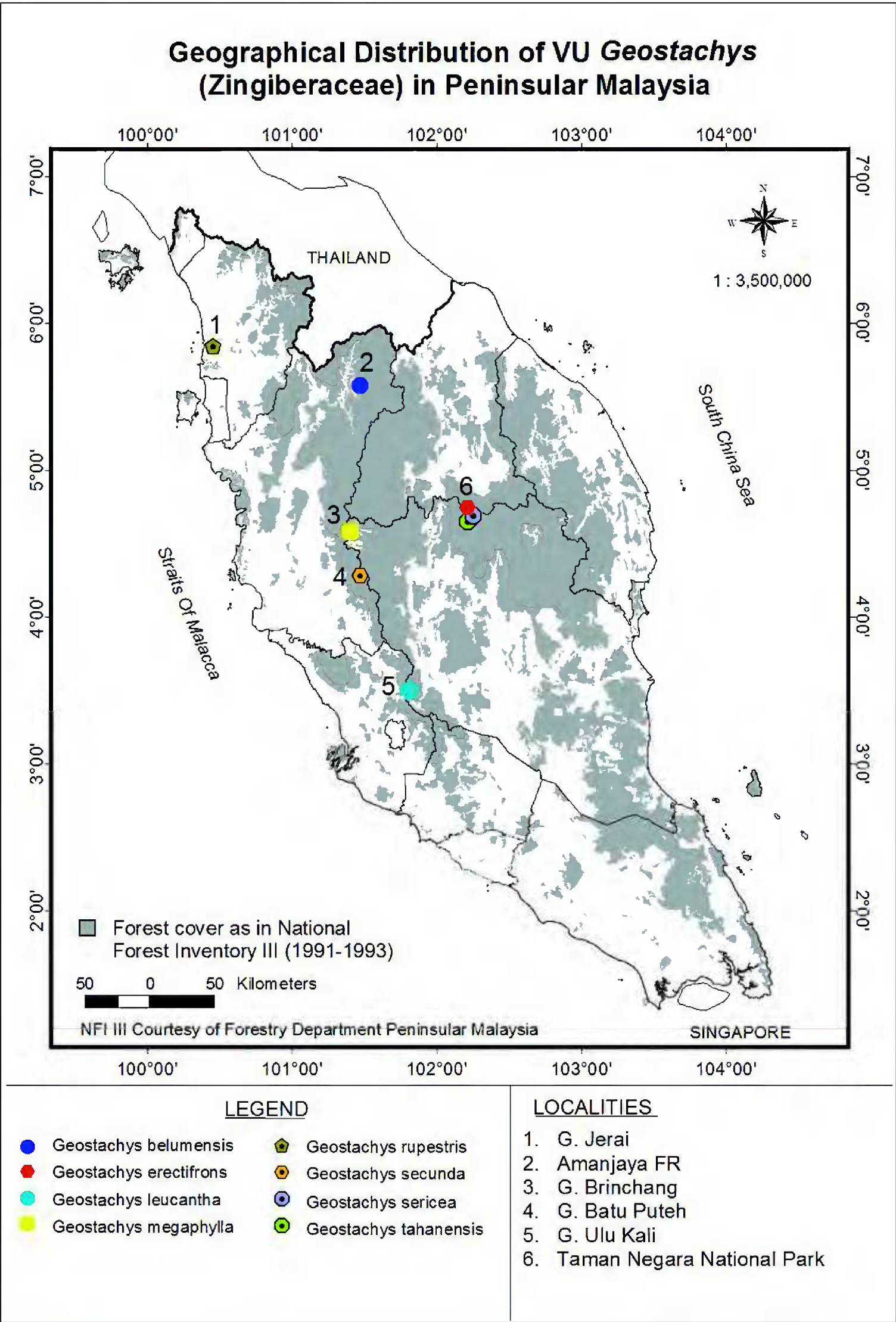


Fig. 2. Distribution of Vulnerable (VU) *Geostachys* species in Peninsular Malaysia.

forest clearance for agriculture, especially around Brinchang town and above, have imposed great pressures on the health of the species' populations. For *Geostachys rupestris*, which is found on G. Jerai (Kedah), dumpsites at forest fringes are slowly degrading the quality of the habitat where clumps once grew. Part of the forested area on G. Jerai serves as a tourist attraction. In the pristine forest of G. Batu Puteh (Perak) *Geostachys secunda* is found along trails used by the local communities and are, therefore, at risk of being trampled.

The two more widely distributed species are *Geostachys densiflora* Ridl. and *G. elegans* Ridl. *Geostachys densiflora* is mainly found in the mountainous area along the Titiwangsa Ridge in the Cameron Highlands and on Fraser's Hill (Fig. 3). Until recently this species was only known from Pahang and Perak but a 2010 expedition to G. Chamar and G. Chamar Anak, Kelantan revealed new sites for *Geostachys densiflora*. These new populations occur at an elevation of 1300 m and 1700 m respectively. This has expanded its AOO to close to 32 km². At the type locality in G. Korbu it was last collected in 1913 and it is not known if it still occurs there; further investigation is needed to verify its status.

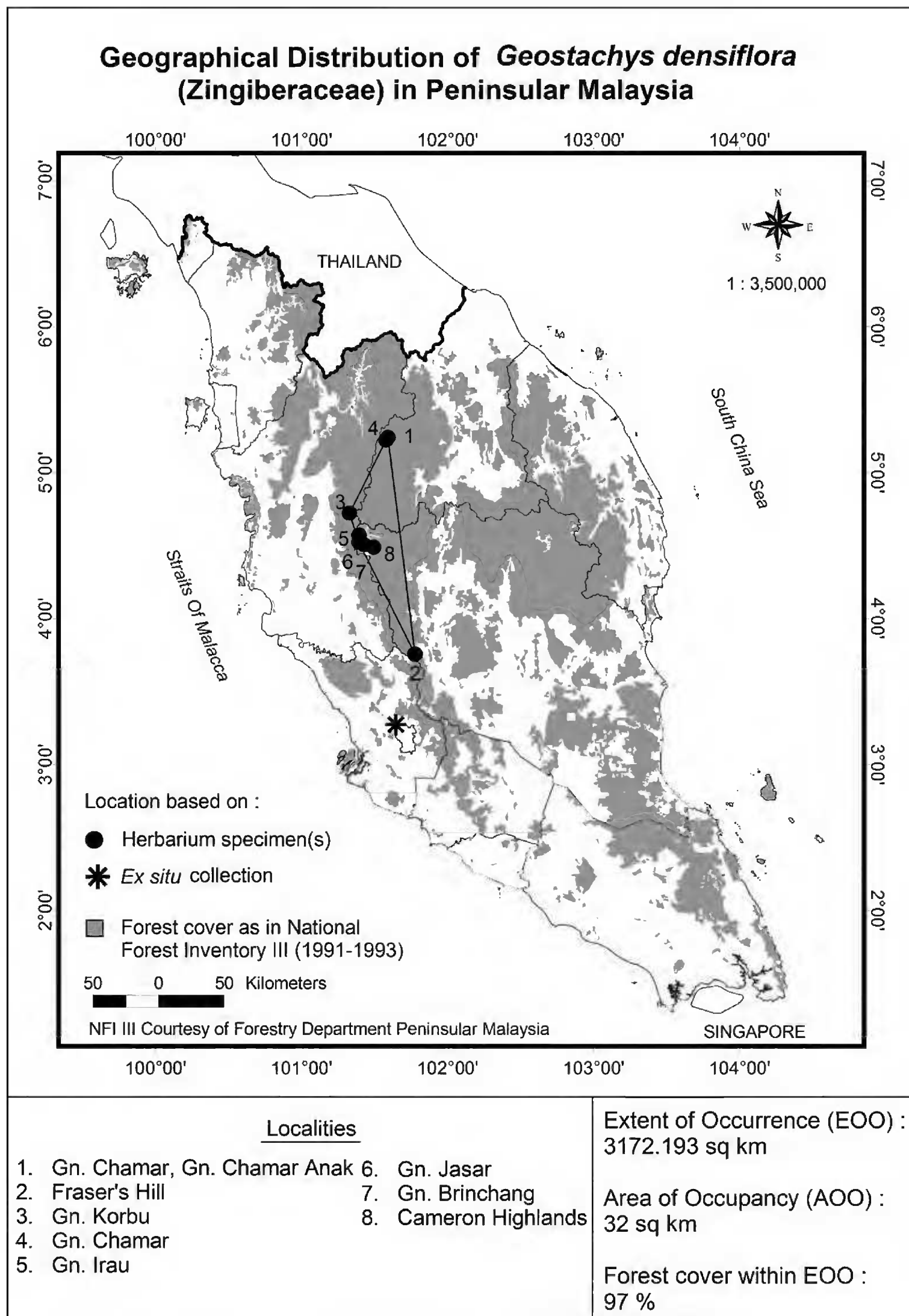
Most populations of *Geostachys elegans* are restricted to the state of Pahang although the type locality is G. Ledang in northern Johor (Fig. 4). The populations in both Taman Negara National Park and G. Ledang State Park are relatively safe within their Protected Areas (PAs).

Geostachys montana (Ridl.) Holttum is Data Deficient (DD) as it could not be relocated on G. Berembun in the Cameron Highlands (Fig. 5) even after several attempts. There are two possibilities, i.e., either the original locality details were inaccurate or it has gone extinct in the wild. Further research is required to determine its status in the near future.

Discussion

Protected areas remain the best places for material for taxonomic research and the most likely place for the discovery of new species. In Malaysia, the pristine conditions of its National and State Parks and other protected forest areas provide the last refuges for rich biodiversity that tropical forests are famed for. For instance, examples of new species discovered from protected areas in Malaysia include two new *Geostachys* species (Lau et al., 2005) in Taman Negara National Park, another *Geostachys* species in Maliau Basin, Sabah (Lim & Lau, 2006), a *Pennilabium* orchid in Endau Rompin National Park, Johor (O'Byrne et al., 2009), two gingers from the genus *Scaphochlamys* in Krau Wildlife Reserve, Pahang (Sam et al., 2010) and 13 new species of *Begonia* from G. Mulu National Park and G. Buda National Park, Sarawak (Sang et al., 2013). These, and many others, indicate that more inventory attention should be given to areas that are 'botanical black holes'. It is anticipated that more new species will be found in the future as the diversity in the protected areas continues to be studied.

With 60% of the world's *Geostachys* species occurring in Peninsular Malaysia, with more than 85% of these taxa hyper-endemic, this region is regarded as the genus



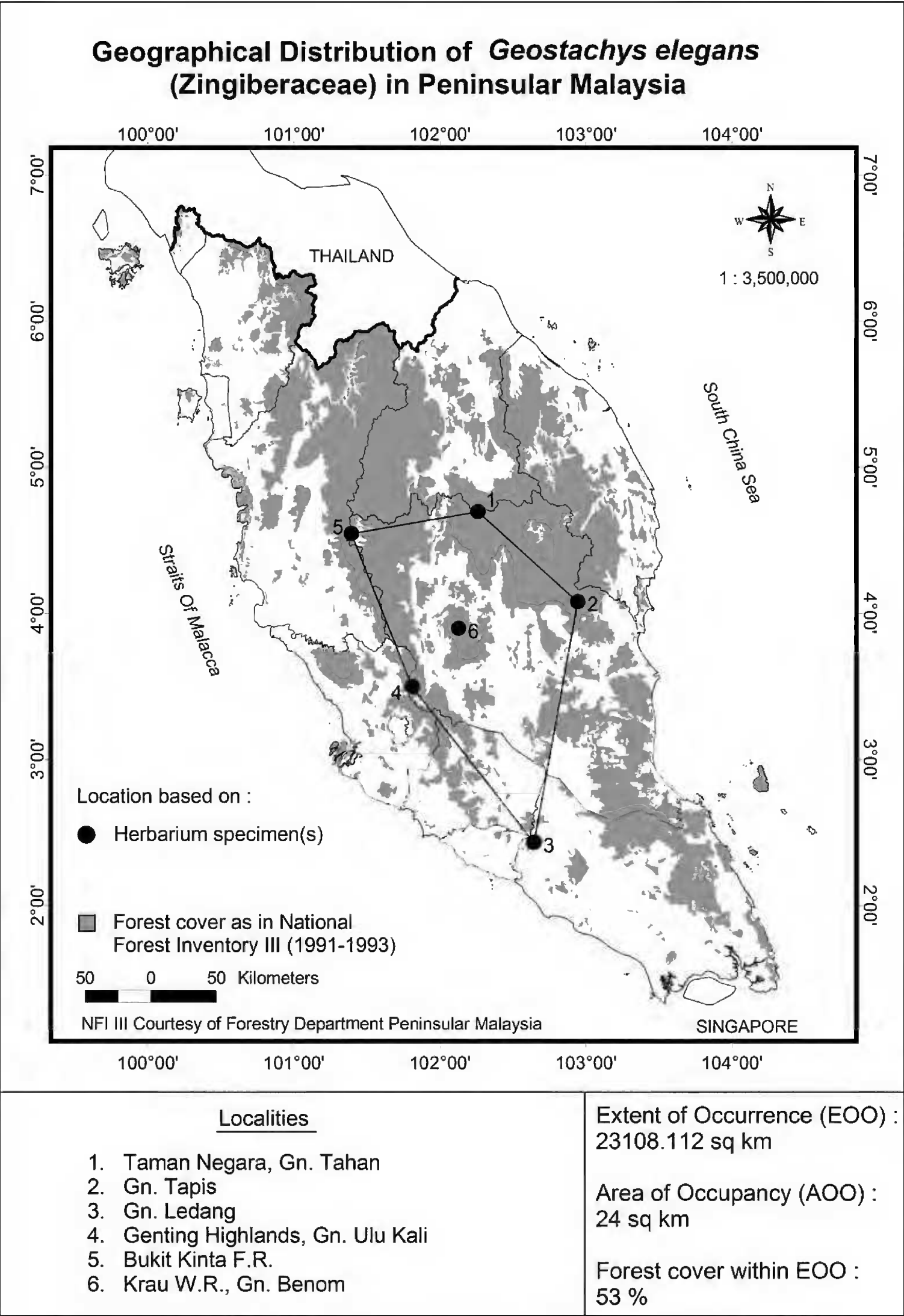


Fig. 4. Distribution of *Geostachys elegans* Ridl. in Peninsular Malaysia.

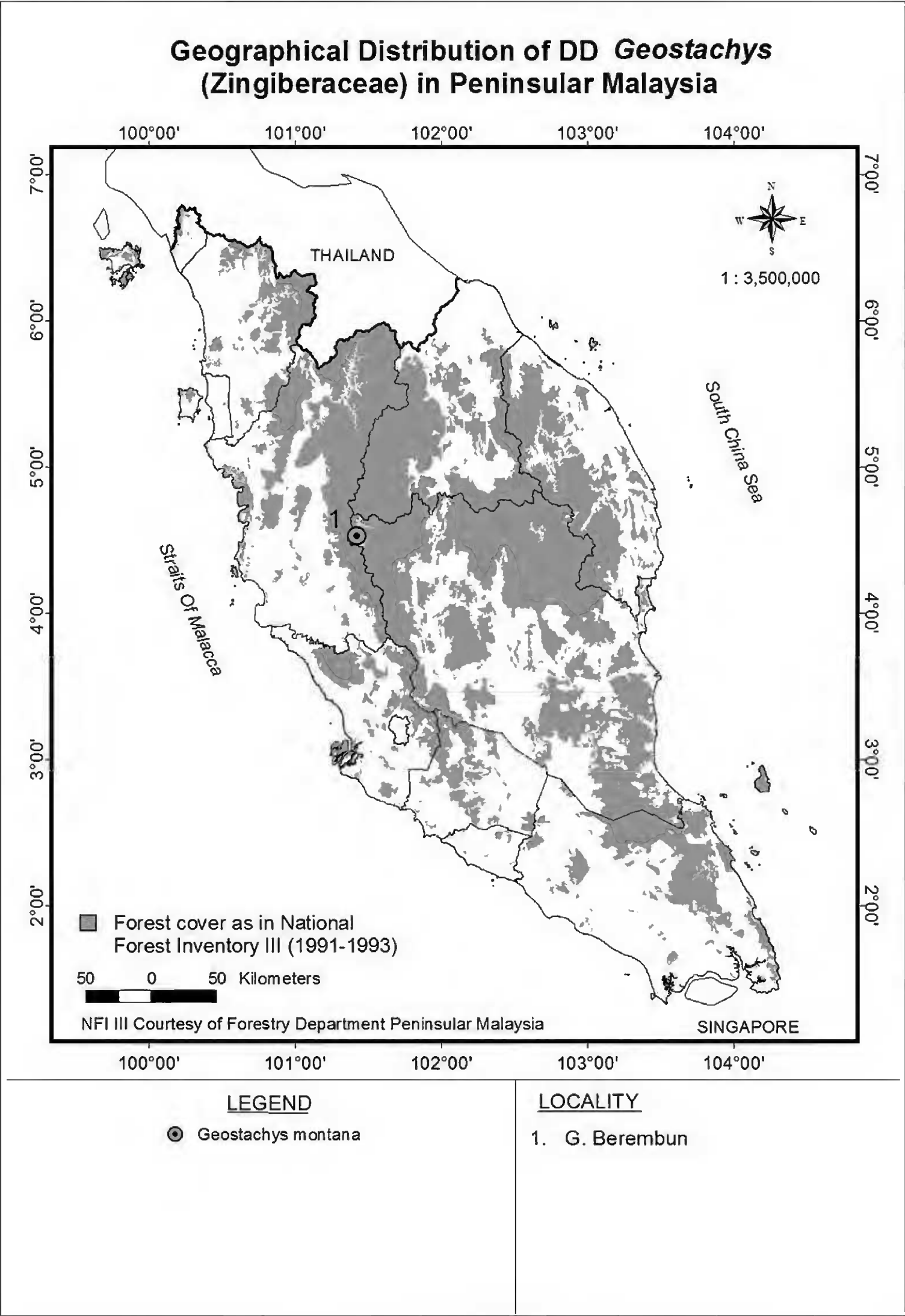


Fig. 5. Distribution of Data Deficient (DD) *Geostachys* species in Peninsular Malaysia.

hotspot. Therefore, conservation of these gingers should be given priority. While some taxa occur in Protected Areas, there are many which do not. These taxa are exposed to threats such as habitat encroachment and land use changes, i.e. in the Cameron Highlands and Genting Highlands. The expansion of forest trail packages by tourist operators in the Cameron Highlands could further disturb the ecosystem due to higher footfall. Currently, there are no specific guidelines and support given to the ecotourism companies to encourage conservation mindfulness. In the Genting Highlands, massive developments over recent decades have altered the forested landscape and environment and consequently affected the viability of all species of flora and fauna. In the development of management plans for such sites, the effects of how changes in land use negatively impact on the environment, and how this can be mitigated, must be researched.

The occurrence of *Geostachys* species in tourist sites also means additional conservation measures to protect the taxa must be adopted. For instance, although the habitat is well-protected in National and State Parks, the populations of *Geostachys* species themselves may not be. Stricter rules and regulations should be imposed on forest trails which are heavily used by tourists. These should include a total ban of removal of any flora and fauna found in the forests, and higher fines if caught doing so. Hikers should not be allowed to clear vegetation for the setting up of camps anywhere in the forest outside designated camping grounds. This is to protect the indiscriminate or unintentional removal of rare plants. Also, unauthorised clearing of new forest paths must be prohibited for the same purpose, to avoid the killing and trampling of plants and disturbance of the ecosystem. Prominent notice boards should be erected at strategic locations to serve as reminders.

There are a few ecotourism models that have set good examples of balanced development, such as can be found on Fraser's Hill and Maxwell's Hill. These places have developed into niche-market tourist attractions. On Fraser's Hill, the annual bird race competition that attracts thousands of people has proven that retaining forested areas is rewarding. The annual event has also directly increased the public's awareness of forest conservation. On Maxwell's Hill, where the state government-owned resort has full administrative authority, including accessibility to the peak, the impact from tourism is very much minimized. For example, only authorised vehicles have access to the hill. Tourists have to be carried in these vehicles from the base of the hill to their destinations and the somewhat antiquated transport style adds allure to the concept of the cool private highland getaway.

The threat assessment process itself has been a daunting task. It has been long believed that taxa which are confined to protected areas are not really at any risk of extinction due to decades-old protection legislation (Chua, 2012). However, each should be reviewed on a case by case basis. It has not been easy to determine the conservation status for some species, especially those from protected habitats where threats are nevertheless believed to exist. The three species in Taman Negara National Park may at first seem to fit into the Rare (RA) category (sensu Chua, 2012), but further analyses showed that they deserved a threatened category. Although their AOO qualified the species under both categories, i.e., not more than 10 km², the RA category

is not suitable for species under threat. Therefore, for the reasons discussed above, the Vulnerable category is more appropriate.

It is clear that the survival of *Geostachys* is very much dependent on the management strategies employed by forest managers who in turn have to balance their management practices with their obligations to deliver government policy. What is needed is that Malaysia's biodiversity heritage is given ample attention and protection so that its full potential can be appreciated not only now but also by future generations.

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